May 14, 1968 R. P. LOTTA 3,382,740

BALL DRILLING MACHINE

Filed Dec. 29, 1965 3 Sheets-Sheet 1

Fig. 1

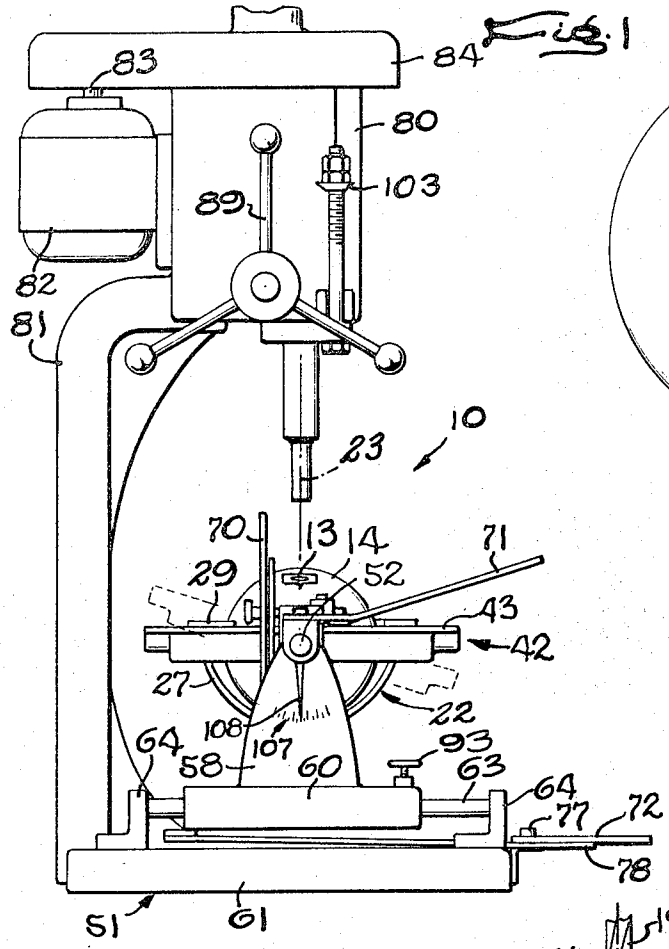


Fig. 2

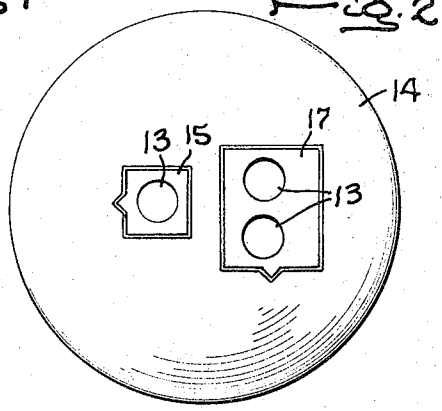
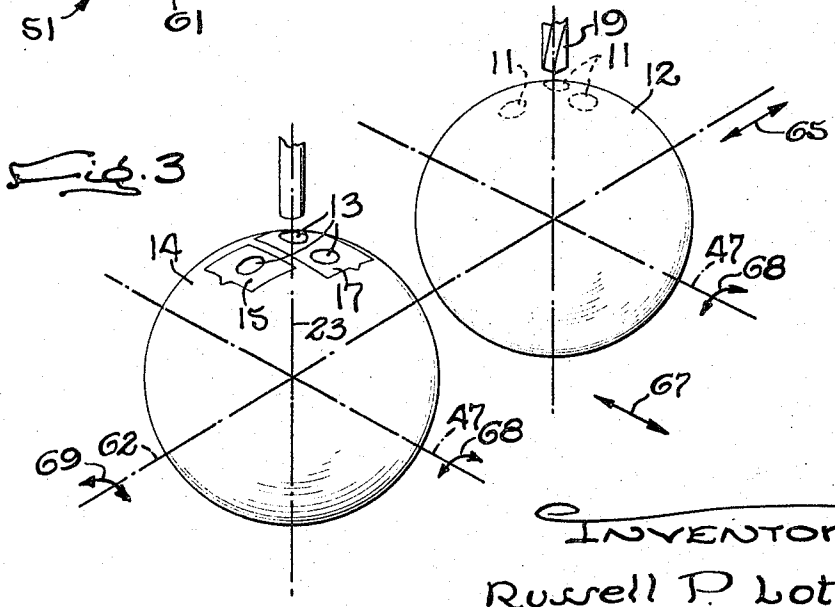


Fig. 3



INVENTOR

Russell P. Lotta

by Wolfe, Hubbard, Voit & Osann

ATTORNEY

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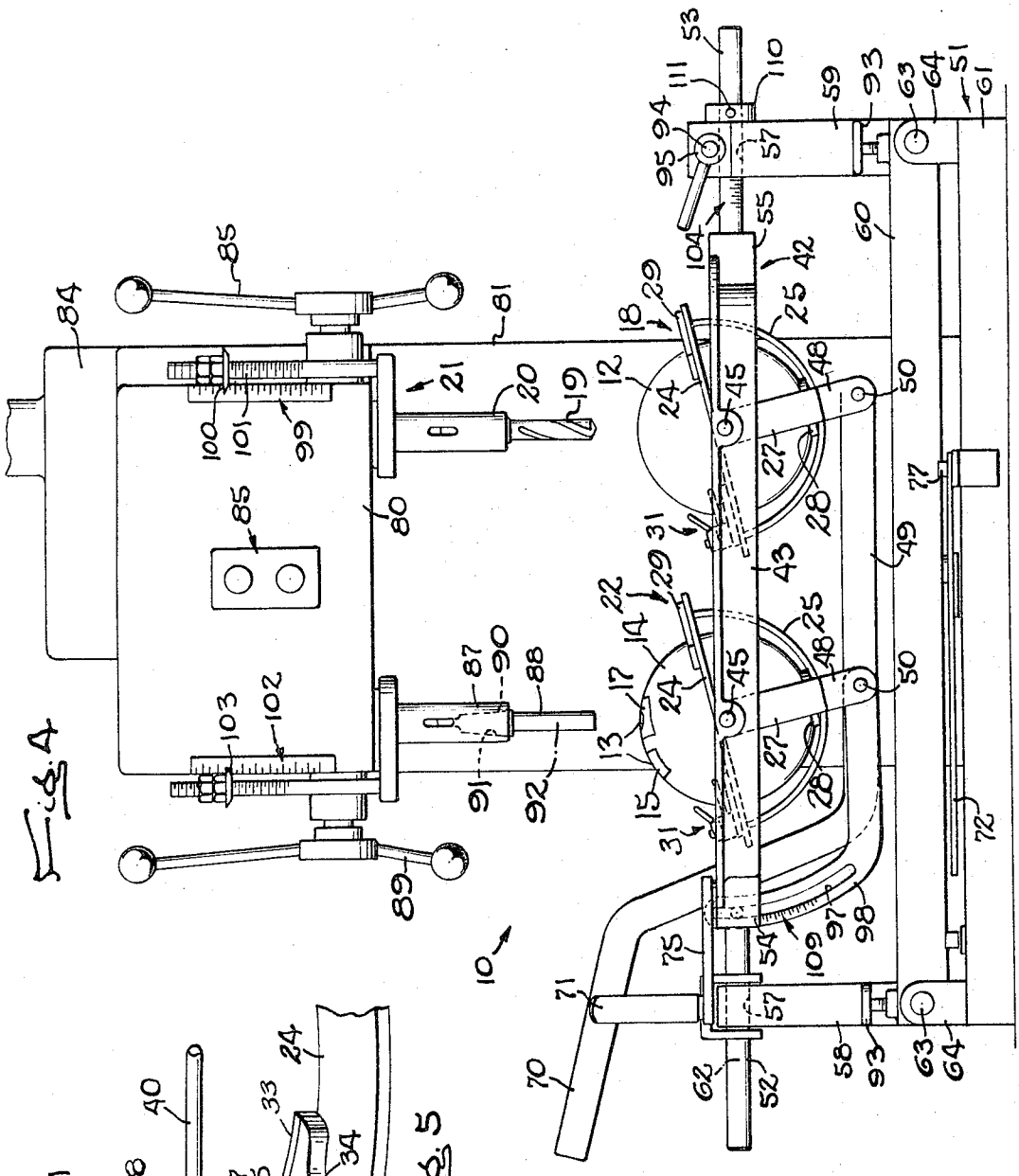


Fig. 4

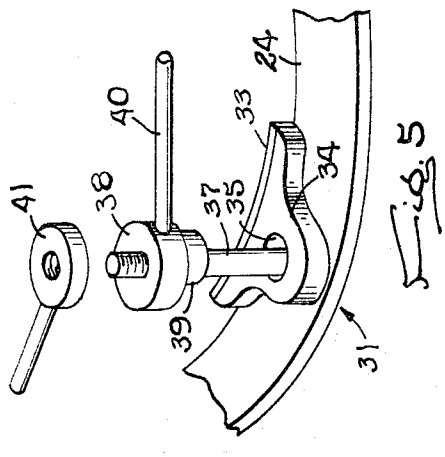


Fig. 5

INVENTOR
Russell P. Lotta
by Wolfe, Hubbard, Voit & Osann
ATTORNEYS

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BALL DRILLING MACHINE

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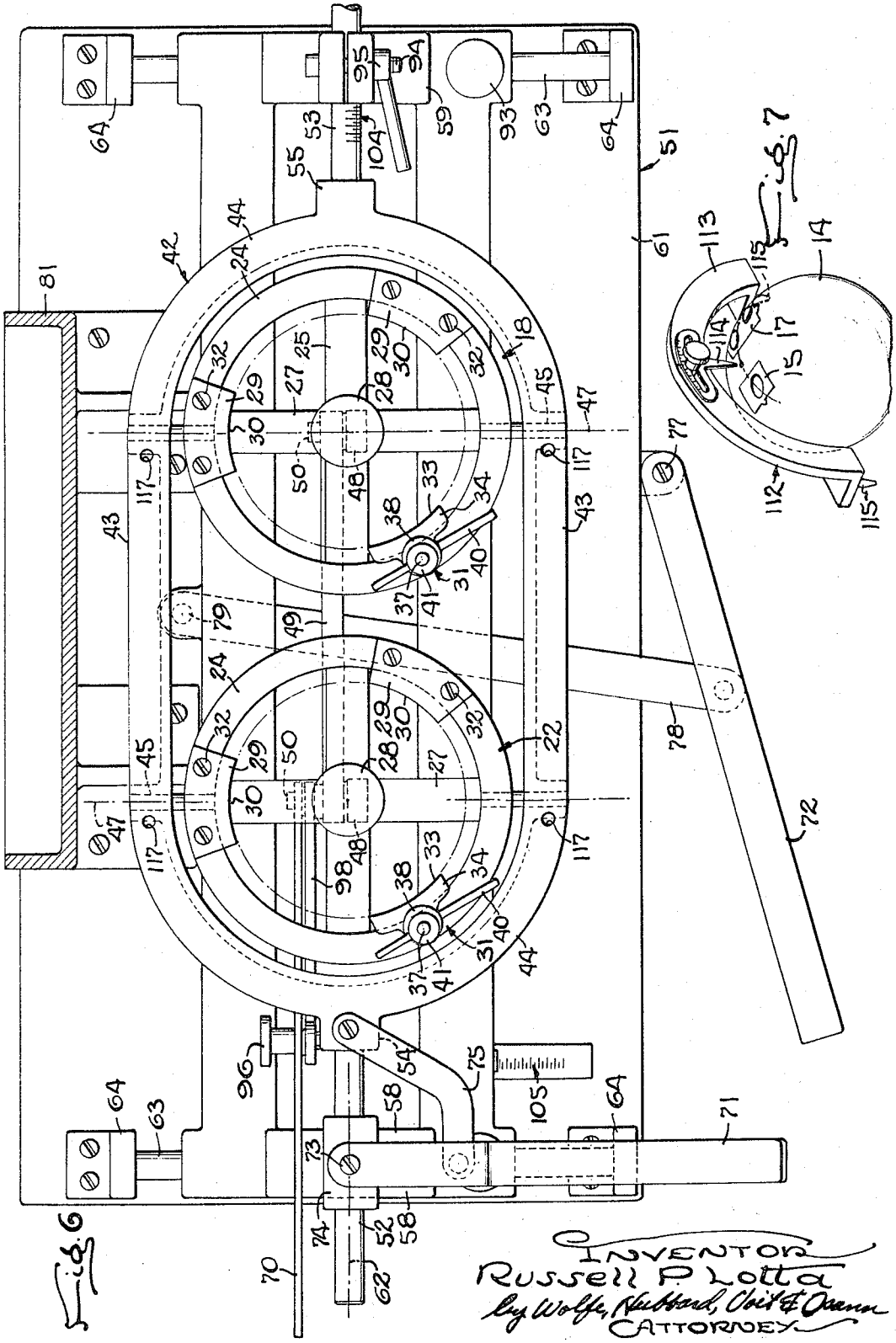


Fig. 6

Fig. 7

INVENTOR
Russell P. Lotta
By Wolfe, Hubbard, Voit & Osann
ATTORNEY

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3,382,740

BALL DRILLING MACHINE

Russell P. Lotta, 3535 Latham, St., Rockford, Ill. 61103

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7 Claims. (Cl. 77—5)

ABSTRACT OF THE DISCLOSURE

A ball drilling machine for forming finger holes in a bowling ball in the positions of holes in a master ball having side-by-side spindles holding a drill and a pilot pin for movement along parallel paths respectively toward a holder for a blank ball and a holder for the master ball. The two holders are mounted on a frame movable perpendicular to the paths of the drill and the pilot pin both from front to rear and from side to side to aline each hole in the master ball with the pilot, and also are tiltable about parallel axes to rock the axis of the hole into alinement with the pilot pin. In addition, the holders are pivotally connected by a link which transmits the rocking of the master ball to the blank ball so that all motion of the master ball in alining a hole with the pilot is automatically and correspondingly transmitted to the blank ball. The holders are locked in each selected position for the drilling operation, and appropriate scales are formed on the positioning means to provide readings regarding hole positions. A locator is mountable over each of the holders with a pointer indicating the vertical center for use in setting the balls correctly in the holders at the beginning of an operation.

This invention relates to a machine for drilling finger holes in bowling balls and, more particularly to the drilling of a plurality of holes in a blank ball in precisely the same relation and having the same pitch or entry angle as a similar set of holes in a master ball fitted to a prospective user's hand.

The principal object of the present invention is to eliminate guesswork in the drilling of finger holes in blank balls according to a set of master holes and to match the master holes precisely in size, position and pitch in a relatively quick and simple operation.

Another object is to position the blank ball for engagement with the drill in a novel and simple manner which insures the duplication of the location and pitch of the master holes.

A more detailed object is to support the master ball and the blank ball for identical rotary motion and translatory motion transversely of the drill to bring the different master holes successively into a preselected operative position and, at the same time, bring corresponding areas of the blank ball into alinement with the drill at the proper angles for duplication of the master holes.

Another object is to provide a drilling machine of the foregoing character which is capable of being produced in quantity at a cost that is competitive with presently available machines, and which can be used in connection with fitting procedures in commercial use.

A further object is to facilitate the rapid and precise movement of the various master holes into the operative position to reduce the time and skill required to perform the positioning operation.

A related object is to use pilot pins fitted in the master holes and projecting outwardly therefrom both to indicate the angular position of the master ball and to cooperate with the machine in bringing each master hole into the operative position.

Still another object is to provide novel holders for releasably gripping the two balls in side-by-side alined positions and to support the blank ball holder for precise duplication of the movements of the master ball used to bring the master holes into the operative position.

The invention also resides in the novel manner of supporting the ball holders for the various motions required to bring successive master holes quickly and easily into the operative position.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a fragmentary side elevational view of a machine embodying the novel features of the present invention, partly broken away and shown in cross-section for clarity of illustration.

FIG. 2 is an enlarged plan view of a master ball usable with the machine in FIG. 1.

FIG. 3 is a schematic representation of the motions imparted to the master ball and the blank ball in the machine.

FIG. 4 is an enlarged fragmentary front view of the machine with parts in moved positions.

FIG. 5 is an exploded fragmentary perspective view of parts shown in FIG. 4.

FIG. 6 is an enlarged fragmentary plan view of the holders and the supporting structure therefor.

FIG. 7 is a fragmentary perspective view of a device for locating the holes on the blank ball.

As shown in the drawings for purposes of illustration, the invention is embodied in a machine **10** for drilling holes **11** in a blank bowling ball **12** in the locations and at the angles of holes **13** in a master ball **14**, that is, a ball or ball-like device with holes that have been fitted to the hand of the prospective user of the blank ball in one of the several ways presently used in the art. While the master ball shown herein is one in which the finger holes are impressions cast in plastic insets **15** and **17** in the ball, it will be evident to those skilled in the art that the other fitting devices may be used, including master balls having a large number of sets of finger holes from which the individual selects the set best fitting his hand, and the type in which tubes are fitted to the fingers and then mechanically clamped in the desired locations and pitch angles.

As in prior drilling devices, the blank ball **12** is mounted in a holder **18** and positioned in the path of a drill bit **19** carried on the spindle **20** of a drill head **21**. By adjusting either the drill head or the holder, a selected area of the ball is alined with the drill for entry of the drill into the ball at the angle selected for the hole. After the first hole is formed, the position of the ball is adjusted relative to the path of the tool to bring the next area of the ball into the proper position. Of course, drills of different diameters are used to form holes of sizes suited for the individual's fingers, and the positioning and drilling operations are repeated for each hole to be formed. In all machines presently in commercial use, the positioning of the ball relative to the drill is a rather complex and time-consuming procedure, and often requires guesswork and approximation, particularly with respect to the pitch of the holes. As a result, accurate custom fitting is expensive and, even then, difficult to obtain.

The present invention contemplates a novel machine **10** for accurately duplicating the master holes **13** in a relatively quick and simple operation which leaves nothing to guesswork and approximation. To these ends, the master ball **14** is supported in a holder **22** for universal translatory motion in a predetermined plane of adjustment and also for universal rotary motion whereby each master hole may be brought into a preselected operative position with the axis of the hole located on a preselected

reference line 23, and the master holder is connected to the blank ball holder 18 to shift the latter through the same motions and thereby move the blank ball 12 into positions relative to the tool precisely corresponding to the positions of the master ball relative to the reference line. In other words, the motions of the master holder necessary to bring successive master holes into alinement with the reference line are transmitted to the blank ball holder to bring corresponding areas of the blank ball into the same positions relative to the drill.

In this instance, the two holders 18 and 22 are upwardly opening, semi-spherical sockets each defined by a ring 24 having an inside diameter somewhat greater than the diameter of the balls to be drilled, a semi-circular strap 25 fastened at its ends to the underside of the ring, and two quarter-circular straps 27 fastened to the ring at points spaced ninety degrees from the ends of the strap 25 and curving downwardly to the midpoint of the latter and fastened thereto, each strap being formed on a radius greater than the radius of the ball to be held in the socket. Above the midpoint of the strap 25 is a disk 28 which forms the bottom support for the ball.

To hold the balls 12, 14 in place in these sockets, two fixed plates 29 having arcuate inner surfaces 30 (FIG. 6) are spaced apart along the ring 24 on one side of the socket for engagement with adjacent sides of the ball resting on the supporting disk 28, and a movable clamp 31 is mounted on the ring on the opposite side of the socket to press the ball firmly against the locating surfaces 30 and hold it releasably in place. As shown most clearly in FIG. 6, the fixed plates are spaced apart approximately 120 degrees and fastened to the top of the ring by screws 32, and the clamp (FIGS. 5 and 6) comprises an arcuate strip 33 mounted on a carrier piece 34 formed with a circular hole 35 loosely telescoped over a stud 37 upstanding from the side of the ring opposite the fixed supports. To operate the clamp, a collar 38 is telescoped onto the stud above the carrier with an eccentric 39 on its underside fitted rotatably in the hole 35 in the carrier. A pin 40 projects generally radially from the collar to provide a handle for rotating the collar and the eccentric, and a nut 41 is threaded onto the upper end of the stud to clamp the eccentric against the carrier. With this arrangement, turning of the eccentric in one direction shifts the carrier toward the fixed supports to press a ball against the supports. When the nut is tightened against the collar, the clamp is locked in place and the ball is positively located in the socket and held releasably in place.

Herein, the two holders are supported in side-by-side relation in a frame 42 having straight and parallel side sections 43 joined together by end sections 44 curving around the remote sides of two holders, each ring 24 having two oppositely projecting pivots 45 formed by pins journaled in bearings at the ends of the straight sections of the frame and mounting the holders thereon for tilting about parallel axes 47 passing through the centers of the balls 12 and 14 in the holders.

Connecting the holders for simultaneous rocking about their parallel axes 47 is a parallelogram linkage (see FIG. 4) formed by at least one link 48 projecting downwardly from the underside of each holder, herein an integral extension of one of the quarter-circular straps 27, and a connecting link 49 parallel to the plane of the frame 42 and pivotally connected at 50 to the lower ends of the links 48. The connecting link is shiftable endwise back and forth to rock the holders in unison about their axes.

To mount the frame 42 on the machine base, indicated generally at 51 in FIGS. 1, 4 and 6, two trunnions 52 and 53 formed by elongated cylindrical rods held in coaxial relation in bores in two coaxial sleeves 54, 55 fast on the ends of the frame project outwardly into bores 57 in two supports 58, 59 upstanding from a horizontal carriage 60 supported on top of a table 61 constituting part of the machine base 51. The rods are movably received in the supports so as to be both rotatable and slidable

therein, and the spacing of the supports is greater than the length of the frame to accommodate back and forth sliding of the latter, from left to right and back as viewed in FIGS. 4 and 6. The pivotal axis 62 defined by the rods 52, 53 is perpendicular to the axes 47 defined by the pins 45 and also passes through the centers of the balls in the holders.

The remaining motion of the holders 18 and 22, in the front-to-rear direction, is produced by movement of the carriage 60 on the table 61. For this purpose, the carriage is supported at its ends on two parallel rods 63 forming slideways supporting the carriage for back and forth movement in a direction perpendicular to the direction of movement of the frame 42 along the rods 52, 53. The front-to-rear rods are fastened at their ends in brackets 64 near the front and rear edges of the table, and are spaced above the top surface of the table. Accordingly, the holders are supported on the base 51 for identical lateral movement in unison along the axis 62 as indicated by the arrow 65 in FIG. 3, identical front-to-rear movement along the rods 63 as indicated by the arrow 67, tilting movement from side to side about the axes 47 as indicated by the arrows 68, and tilting movement from front to rear about the axis 62 as indicated by the arrow 69.

Preferably, manual operators 70, 71 and 72 are provided to facilitate the positioning of the holders relative to the base. The operator 70 is an elongated handle integral with one end of the connecting link 49 and inclined upwardly and outwardly to one side to facilitate the rocking of the holders 18, 22 about the axes 47. The operator 71 is a lever pivoted at one end at 73 on a yoke 74 (see FIGS. 4 and 6) having legs straddling the upper end of the support 58 and telescoped onto the rod 52, the lever being connected intermediate its ends to a link 75 pivoted at its other end on the adjacent sleeve 54 on the frame 42. Thus, as this lever is swung back and forth about its pivot, the link 75 slides the frame from side to side. Front-to-rear movement of the carriage 60 is produced by a second lever 72 pivoted at 77 on the front of the table 61 to swing about a vertical axis and connected by a link 78 to a pivot 79 on the rear side of the carriage. Pulling the lever forward, counterclockwise in FIG. 6, pulls the carriage toward the front of the frame, while clockwise motion of the lever pushes the carriage rearward.

As shown in FIG. 4, the drilling head 21, which is of standard construction, is mounted in a housing 80 overhanging the table 61 and supported on the upper end of a column 81 upstanding from the rear edge portion of the table, this column constituting another part of the machine base 51. The drill spindle 20 extends downwardly from the underside of the housing and is driven in the usual manner by a motor 82 (FIG. 1) having an output shaft 83 connected to the spindle by a drive belt enclosed in a shield 84. Start and stop controls 85 (FIG. 4) are provided on the front of the housing. Herein, the drill spindle is located near the right side of the housing above the holder 18 to support drill bits in alinement with the blank ball 12 in the holder, and is movable vertically through forward and return strokes by means of a hand wheel 85 connected to the spindle in the usual manner.

Depending from the housing 80 near the left side thereof above the holder 22 is a second spindle 87 for holding a pilot pin 88 for entry into one of the holes 13 in the master ball 14. This spindle also is supported on the housing for vertical movement by a hand wheel 89, but need not be rotatable. The pilot pin shown in FIGS. 1 and 4 is formed with an upwardly tapered shank 90 above a cylindrical body of selected outside diameter, and the spindle is fromed with an upwardly tapering chuck 91 for receiving the shank. The drill bits used in the machine preferably have similar tapered shanks fitting in a tapered chuck in the spindle 20 for quick installation and removal of different sizes of bits for forming different sizes of holes in the blank balls.

While a selected pilot pin **88** may be inserted in the tapered chuck **91** of the spindle **87** prior to adjustment of the master ball's position, the positioning operations may be completed more quickly and easily by inserting a selected pilot pin in each of the holes **13** of the master ball, using pins fitting the holes snugly, then adjusting the position of the master ball and its holder to aline the upper end of the shank generally with the opening into the chuck, and finally working the spindle downwardly onto the shank while nudging the ball or the holder as necessary to bring the shank into precise alinement with the chuck. When the spindle is fully down over the shank with the body of the pilot pin in the master hole, the master ball is positioned with the master hole in the operative position, that is, the position in which the longitudinal axis of the master hole is alined with the axis of the spindle **87**, this axis being the aforementioned reference line **23**.

It will be seen that the spindle **87** and the pilot pin **88** operate to lock the master ball **14** in position and thus serve to hold the blank ball **12** stationary in a position precisely corresponding to the position of the master ball when the pilot pin is in a master hole. The balls also may be locked in a selected position by a pair of set screws **93** (FIGS. 1, 4 and 6) threaded through the carriage **60** to grip the slide bars **63**, a screw clamp formed by a bolt **94** (FIGS. 4 and 6) inserted through alined holes in the split upper end of the support **59** with a wing nut **95** threaded onto one end of the bolt to clamp the split end of the support against the rod **53**, and a screw clamp **96** (FIG. 6) for holding the link **49** stationary relative to the frame **42**. This clamp has a stem threaded into the sleeve **54** through an arcuate slot **97** (FIG. 4) in a generally L-shaped gauge bar **98** pivoted at one end on the pivot pin **50** on the link and curving upwardly past the rod **62**. When this bar is clamped against the sleeve, the parallelogram linkage is locked in place.

With the master ball **14** in position relative to the pilot pin **88**, the drill spindle **20** is lowered to feed the drill bit **19** into the blank ball **12**. The bit used for each hole has the same outside diameter as the pilot pin that fits the master hole, and thus produces a hole of the same size in the blank ball. The depth of the hole is indicated on a gauge **99** on the housing **80** by a pointer **100** on a bar **101** movable vertically with the spindle. A similar gauge **102** and pointer **103** on the pilot spindle indicate the depth of the master hole when the pilot pin is seated in the chuck **91**.

After the first hole **11** is formed in the blank ball **12**, the next hole is formed simply by releasing the holders **18**, **22** for movement, adjusting the position of the master ball **14** laterally, angularly, and from front to rear to bring another master hole into the operative position (in which the shank of the pilot pin fits precisely in the spindle), locking the holders in place, and then feeding the drill into the blank ball. This procedure is repeated for each master hole. Accordingly, the holes in the master ball are accurately duplicated in the blank ball with the same relative positions and pitches.

Preferably, gauges are provided on the various movable parts of the machine to provide measurements from which balls may be duplicated in the future. For this purpose, graduations **104** are marked on one or both of the trunnion rods **52**, **53**, a scale **105** (FIG. 6) is mounted on the table **61** beneath the carriage **60**, an arcuate scale **107** (FIG. 1) is mounted on the support **58** beneath a pointer **108** swingable with the trunnion rods, and the L-shaped gauge bar **98** is graduated at **109** to indicate the amount of tilting of the holders **18**, **22** about their axes **47**. If the hole sizes and the position readings provided by these gauges and the depth gauge **99** are recorded, the holders may be repositioned in the same positions previously used to drill a set of holes, and duplicate holes may be drilled. A collar **110** (FIG. 4) preferably is telescoped onto the trunnion rod **53** outside the support **59** and adjustably held in place by a set screw **111** to form a stop cooperating with the support to determine the lateral position of the frame **42** if it is necessary to change the lateral position and later return to the previous position. The graduations **104**, of course, can serve the same purpose.

Blank balls are manufactured with a heavy spot which maintains the balance of the ball after the finger holes **11** are drilled, the finger holes being located around the heavy spot which is suitably marked on the ball. To facilitate the setting up of the balls **12** and **14** for drilling of the finger holes adjacent the heavy spot, a locator **112** (FIG. 7) is provided with an arch **113** for extending across the ball in the holder **18**, **22** with a depending pointer **114** adjustably positioned at the center of the arch. At the ends of the locator are two depending pins **115** which fit into holes **117** (FIG. 6) in the top of the frame **42** on opposite sides of each holder to support the arch on the frame with the pointer precisely located over the center of the ball in the holder. With this arrangement, the pointer may be centered on the intersections of the axes **47** and **62**.

The locator **112** first is positioned over the master ball **14** and the latter is adjusted to position the pointer midway between the holes **13**, as shown in FIG. 7, before it is clamped in place. Then the locator is positioned over the blank ball **12** which is adjusted in its holder **18** until the heavy spot is under the pointer, and the blank ball is clamped in place. Accordingly, the heavy spot is centered between the holes that are to be formed in the blank ball.

I claim as my invention:

1. In a machine for drilling holes in a blank ball in accordance with the positions and pitch angles of holes in a master ball, the combination of, a base, a drilling head on said base for supporting a drill of preselected outside diameter for movement along a predetermined path through forward and return strokes, a pilot pin of said preselected outside diameter, means on said base for supporting said pilot pin parallel to said path and moving the pin back and forth along a second path parallel to said predetermined path, a first holder disposed along said predetermined path to support the blank ball for engagement with the drilling tool, a second holder disposed along said second path to support the master ball for engagement with the pilot pin, a carriage mounted on said base for back and forth movement in a first direction perpendicular to said paths, a frame supported on said carriage for back and forth movement in a second direction perpendicular to said first direction, said frame being pivoted on said carriage for rocking movement relative to the table about a predetermined axis perpendicular to said paths, and said holders being pivoted in side-by-side relation on said frame for rocking relative to the frame about parallel axes perpendicular to said predetermined axis, a linkage connecting said holders for rocking in unison about said parallel axes, and separately operable means for feeding said drilling head and said pin-supporting means along said paths to bring the pilot pin into one hole of the master ball and thereby position the blank ball relative to said predetermined path in accordance with the positioning of the master ball relative to said second path for duplication of the holes in the master ball.

2. The combination defined in claim **1** in which said frame is supported on said carriage by means of trunnions projecting from opposite sides of the frame along said predetermined axis and both slidably and rotatably received in supports on said table spaced apart a distance substantially greater than the length of said frame to accommodate back and forth lateral movement of the frame between said supports.

3. The combination defined in claim **1** in which said holders are supported on said frame by means of pivots projecting from opposite sides of said holders along said parallel axes and rotatably supported on said frame.

4. The combination defined in claim **1** in which each

of said holders is formed with a part-spherical open-sided socket having a bottom support, fixed supporting means on one side of the socket for engaging one side of the ball resting on said bottom support, and movable clamping means on the other side of the socket for holding the ball releasably against said fixed supporting means.

5. The combination defined in claim 1 in which said pin-holding means is formed with a tapered chuck opening toward said second holder, and said pin is formed with a correspondingly tapered shank to enter said chuck while the pin is fitted in a hole in the master ball and substantially alined with said chuck.

6. In a machine for drilling holes in a blank ball in accordance with the positions and pitch angles of holes in a master device, the combination of, a base, a drilling head on said base for supporting a drill for movement along a predetermined path through forward and return strokes, means for supporting a pilot and moving the latter back and forth along a second path, a first holder for supporting the master device along said second path for engagement of the pilot with said holes, a second holder on said base for supporting the blank ball along said predetermined path, means supporting said first holder for selective positioning of the master device laterally of said second path to aline each of said holes with the second path and also supporting the holder for turning to aline the axes of the holes with the second path, clamping means for locking said first holder in place with the axis

of a hole aligned with said second path, and means connecting said holders together and moving said second holder relative to said predetermined path automatically and corresponding to the movements of said first holder relative to said second path, thereby positioning and locking said second holder relative to said predetermined path in accordance with the position of said first holder relative to said second path for duplication of each hole in said blank ball by a forward movement of said drilling head when a hole of the master device is alined with said second path.

7. The combination defined in claim 6 further including a locator mountable selectively over each of said holders in the same position relative to each, and having a pointer indicating the center of the ball for positioning of preselected areas of the two balls in selected positions relative to the two holders.

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FRANCIS S. HUSAR, *Primary Examiner.*